Space Weather Technical Forecast

Issued on Friday, 04 February 2022 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1/R2 Radio Blackouts) throughout. Chance of isolated G1/Minor Storm activity on days 1 and 2 (04 and 05 February).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was low, with a number of C-class flares observed. The majority of the flares were from AR2936 (Ehi/Beta-Gamma), a large, complex and mature region nearing the northwestern limb. AR2940 and AR2941 are both Eai/Beta regions in the northeast quadrant, with AR2941, the most active of these two regions as it rotates onto the northeastern limb. The other notable region is AR2939 (Dho/Beta), which is large, but relatively stable. Two further regions are both weak and benign. Two CMEs have been observed leaving the eastern and western limbs of the Sun in the last 24 hours, with neither of these appear likely to be Earth-directed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1, has varied between 500km/s and 580km/s due to the influence of the CME which arrived on 01 February, reaching a peak of 580km/s at 04/0013 UTC. Density was mainly around average, but with two periods of above average density between 031200-1730UTC and 03/2230-04/0440UTC, reaching a peak of 30ppcc at 03/2352UTC. Total magnetic field strength started moderate, but soon became weak. The field strength then increased to moderate levels from 03/2315UTC, reaching a peak of 12nT at 04/0707UTC. Bz has been mainly weakly negative, but started to become moderately negative from 04/0400UTC, reaching a negative peak of -10nT at 04/0856UTC. These observations suggest that the Earth is under the influence of the trailing magnetic cloud from the CME, with embedded structures resulting in then rises and falls in the various values. Phi angle has been mainly negative (towards the Sun), with only brief positive rotations. Geomagnetic activity has been generally Unsettled to Active.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV), diurnally fluctuated between background and moderate levels, with a peak value of 371 pfu at 03/2030 UTC. The associated 24-hour electron fluence has been well below the Active threshold (1e8 integrated pfu), with a value of 7.21e6 integrated pfu at 04/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly low, with a chance of M-class flares and a very slight chance of X-class flares.

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Met Office Space Weather Technical Forecast

Solar Wind / Geomagnetic Activity: Solar winds are likely to remain elevated through much of day 1 (04 February) due to the effects of a CME which arrived at Earth on 01 February, with a decline then likely on day 2 (05 February) with winds also easing. A coronal hole high speed stream (CH HSS) is forecast to connect with the Earth on day 2, leading to speeds of 500km/s and a chance of G1/Minor Storms. A further CH HSS connection with similar speeds is then expected on day 3, but is only forecast to produce Active intervals, with a slight chance of G1/Minor Storms. Activity on day 1 is expected to be Unsettled to Active with a risk of G1/Minor Storms. Aside from the risk of storming, activity on days 2 and 3 is expected to be mainly Unsettled with a chance of Active, but is then expected to return to Quiet to Unsettled conditions on day 4.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is forecast to be at background to moderate levels but with a slight chance of rising close to or just above the S1 level given any significant M-class flaring. High energy electron flux (greater than 2MeV) is likely to remain below the high (1e3 pfu) threshold through days 1 to 3 (04 to 06 February), with a chance of exceeding the threshold on the diurnal high on day 4. Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold

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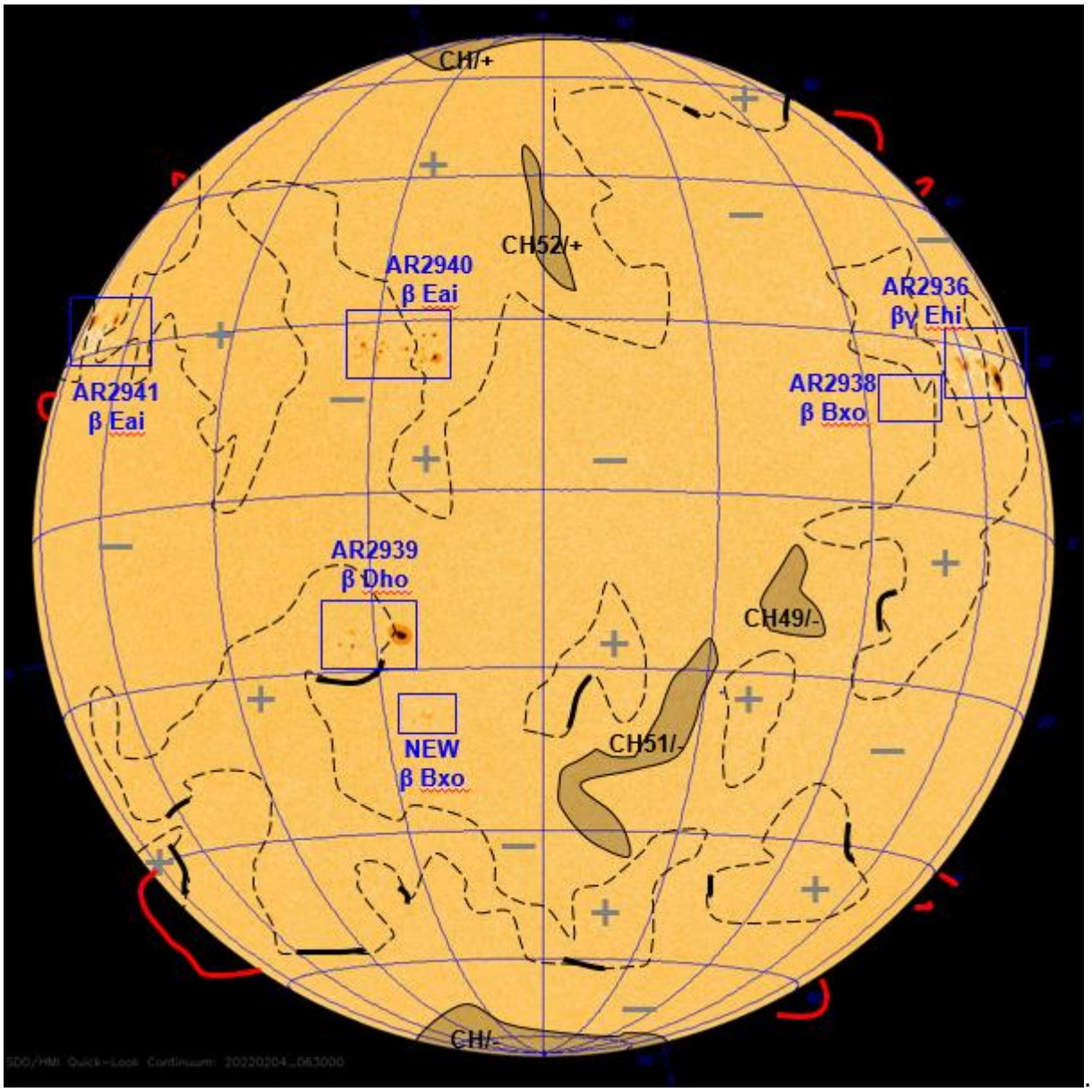
Figure 1. Solar Analysis Valid 04/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun on 29 January and arrived at Earth on 01 February continues to affect the Earth, with elevated solar wind speeds and a moderate magnetic field strength. The Earth is now within the magnetic cloud of this CME, with the effects of this feature likely to decline through day 2 (05 February).

The high speed stream from coronal hole 49 is expected to connect with the Earth on day 2 with speeds of 500km/s possible, based on persistence data and analysis of STEREO A data, which is around 2.5 days ahead of Earth. A high speed stream from coronal hole 51 is then expected to connect with the Earth on day 3 (06 February), producing similar speeds.

As the Earth is in the magnetic cloud from the CME Active intervals are expected with a chance of G1/Minor Storms on day 1 and perhaps into day 2, especially given the strength of the total magnetic field and speed of the solar wind. Further G1/Minor Storm intervals are then possible on day 2 as the high speed stream from coronal hole 49 connects with the Earth. Active intervals are then considered most likely from the connection with the HSS from coronal hole 51, based on behaviour during the previous rotation. Quiet to Unsettled intervals are then forecast for day 4.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	30	40	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity – Earthbound Coronal Mass Ejections

None expected

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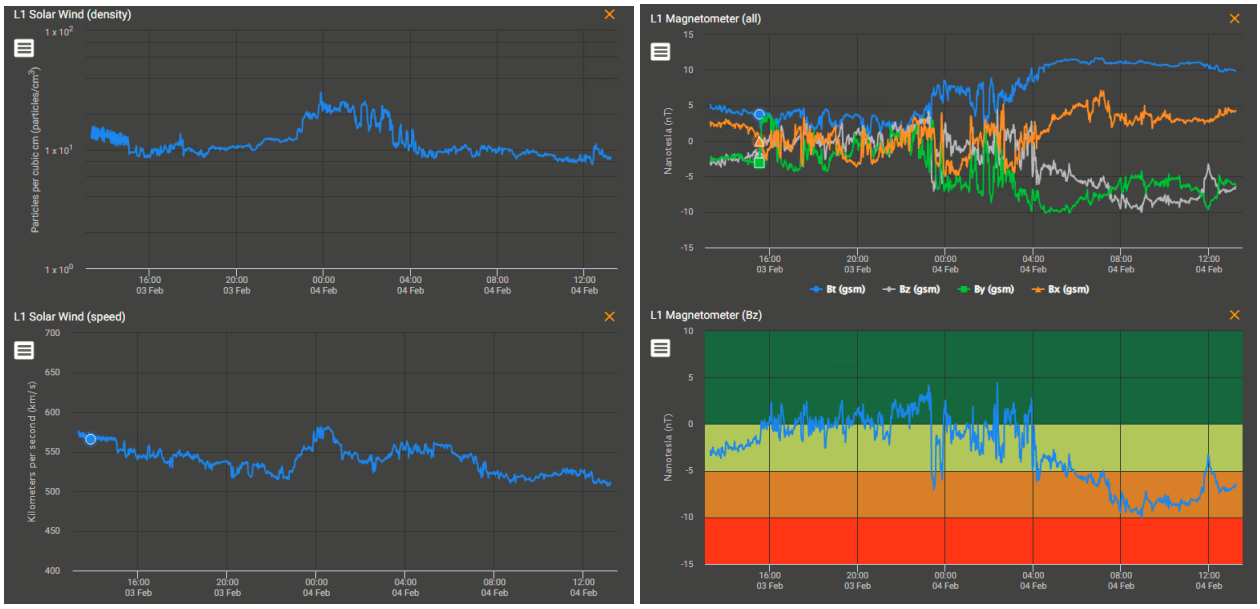
Figure 2: DSCOVR/L1 solar wind observations



Radio Blackouts - X-Ray Flares:

Solar activity is expected to remain mainly low over the next four days, with a slight chance of M-class flares and a very low risk of X-class flaring.

There are four significant sunspot regions on the visible disc. AR2936 in the northwest quadrant, has become more active through the last 24-hours, following a relatively dormant period through the previous seven days. Two regions in the northwest quadrant 2940 and 2941 are both classified Eai/Beta and present a significant flare risk. A large region in the southeast quadrant, appears complex but carries a lower risk of M-class flares. Two further regions, one in the northwest and one in the southeast are considered weak and benign.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

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Figure 3: GOES-16 X-ray flux

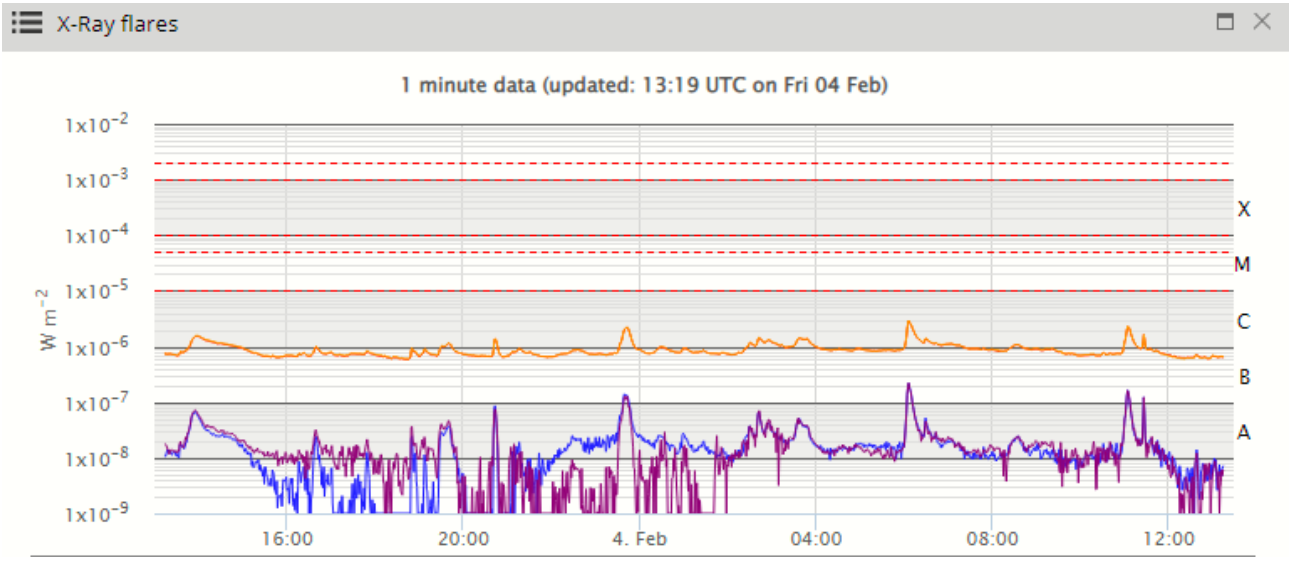

Figure 3: SDO HMI intensitygram and magnetogram imagery of AR2936 (Ehi/Beta)

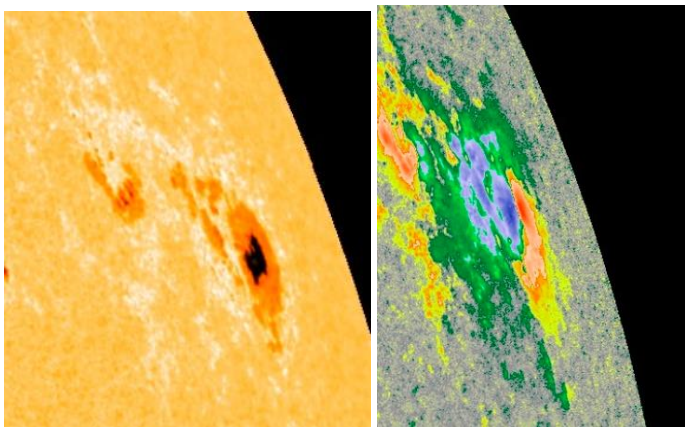

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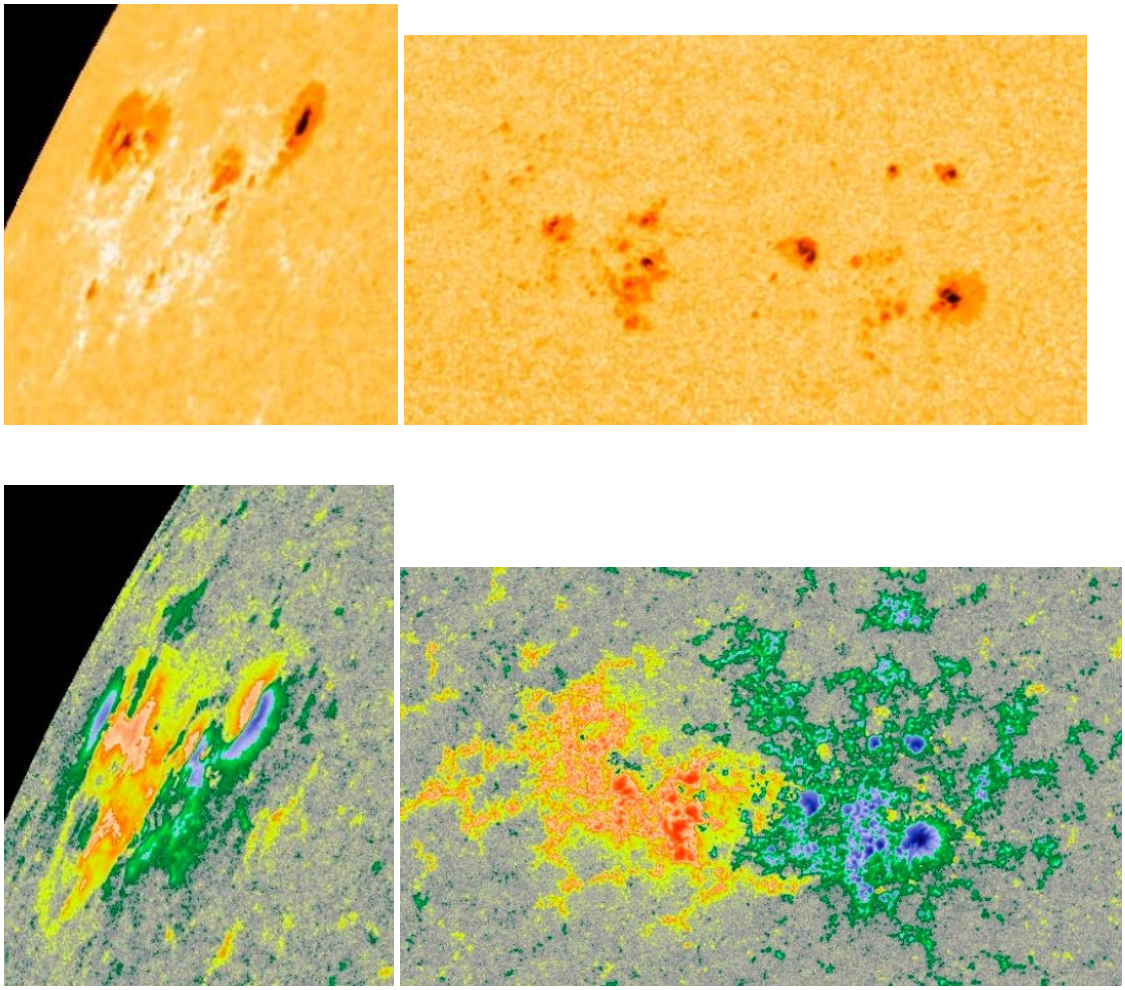
Figure 4: SDO HMI intensitygram and magnetogram imagery of AR2941 (left) and AR2940 (right) both classified as (Eai/Beta)



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. Solar radiation storms are not likely in the period, however there is a slight chance (5%) for proton fluxes to rise given any significant flaring, predominately from AR2936 positioned in the northwest quadrant.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is currently at moderate to background levels, with this likely to continue within the heightened magnetic and solar wind conditions as a result of the CME magnetic cloud. Two high speed streams are due to connect with the Earth, one on 05 and one on 06 February, which are likely to further distort the radiation belts and redistribute electrons away from the belts. Electron flux may start to exceed the high (1e3 pfu) threshold on diurnal highs through day 4 (07 February) as geomagnetic activity is expected to decline.

Electron fluence values are likely to show a slowly rising trend through the period, with the Active (1e8 integrated pfu) threshold, unlikely to be reached.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	10	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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